

No. 12 *How To Put Up Antennas*
RADIO SERVICING METHODS



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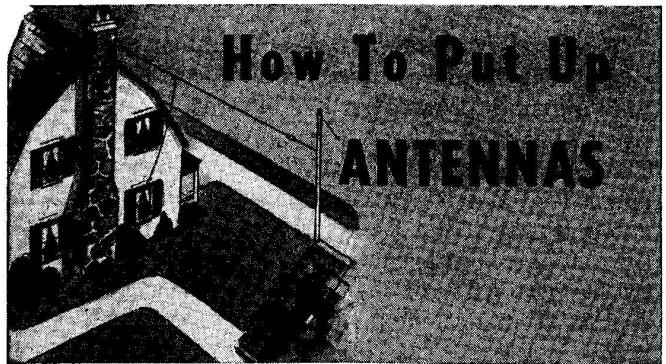
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How To Put Up ANTENNAS



ALTHOUGH outside antennas for broadcast-band receivers are no longer as popular as they once were, there are still specific locations in which they can be very useful. One such location is a country section far from broadcast stations; here a good antenna system is needed to increase signal strength. Another is a city where there is considerable interference from electric motors, neon signs, and other electrical devices; here a noise-reducing antenna is necessary to help overcome this man-made static.

There are also certain types of sets that should use outside antennas. Short-wave and f.m. receivers, for example, frequently need them for best reception.

You can see, then, that there are possibilities of your making extra income by installing antennas. Although you will seldom be called in because a customer has decided he wants an antenna, you can get a surprising number of such jobs from your regular service calls. When you find that reception suffers from lack of a good antenna, point out that fact to the customer. Often you can sell him a better installation.

Of course, an antenna installation really involves more construction work than a servicing job, and you may prefer not to take it up. However, you should know something about it, because your customers will expect you to advise them. Installing an antenna is not usually very difficult. In this RSM Booklet, we'll give you instructions for putting up the chief types.

TYPES OF OUTDOOR ANTENNAS

There are two general types of outdoor antennas in use. By far the more common is the one shown in Fig. 1. This antenna looks somewhat like the letter L upside down—hence it is known as the inverted L antenna. There is a horizontal aerial wire, called the "flat top," and a lead-in wire running from this flat top to the antenna post of the receiver. Another wire goes from the antenna coil to ground. Signals are picked up both by the flat top and by the lead-in wire, with the best reception from stations in the direction indicated by the arrow in Fig. 1. That is, stations are received best in the direction away from the end to which the lead-in connects. For general use, particularly for broadcast-band reception in a noise-free location, the inverted L antenna gives very good results.

► Fig. 2 shows the other common antenna system. This antenna is known variously as a doublet, as an all-wave antenna, or as a noise-reducing antenna. There is a flat-top portion divided into sections by an insulator, which in turn is connected through a transformer to a pair of wires known as a transmission line. The transmission line acts as the lead-in.

The doublet antenna picks up signals only with the flat-top portion of the aerial. Any signals picked up by one wire of the transmission line are also picked up by the other wire, and both try to cause a current flow in

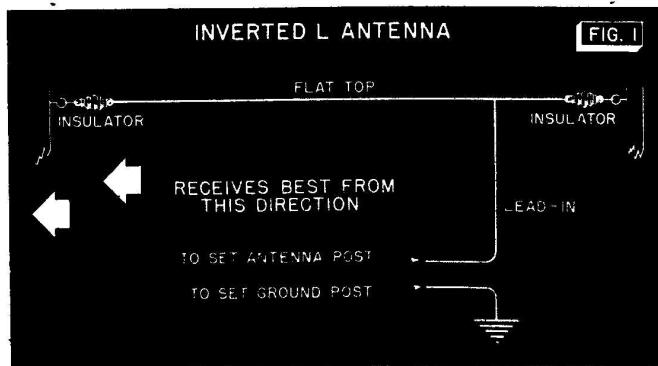
the same direction—either up or down both wires. Therefore, these currents flow in opposite directions through the primary of the set antenna coil, and cancel each other. On the other hand, the voltage induced from the antenna causes a *circulating* current through the transmission line and the set antenna coil. Hence, signal voltages picked up by the flat top will be transferred to the receiver.

Fortunately, most noise signals exist close to the ground, near their sources. If the doublet is mounted high above them, it will pick up very little noise, and since the transmission line picks up neither noise nor any other signal, the amount of noise fed into the receiver will be small. That is why the doublet is called a noise-reducing antenna.

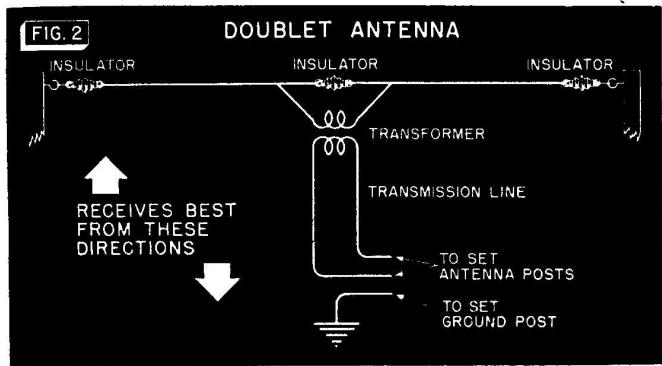
PRELIMINARY STEPS

Let us suppose you have tentatively agreed with the customer on the installation of an antenna. Before you can establish any exact price, you will have to survey the location to see just what is necessary.

First of all, is an antenna permitted? Many modern apartment-house developments do not permit antennas. (In most instances of this kind, however, there is a built-in antenna system.) Also, if the receiver owner rents the property instead of owning it, it will usually be necessary to obtain permission from the property owner for the installation of an antenna.



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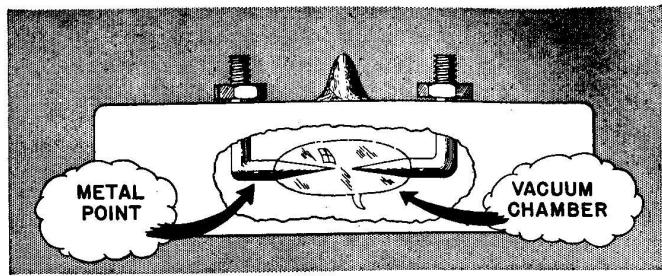


FIG. 3. This sketch shows the inner details of one standard model of lightning arrester.

Next, consider whether an antenna can be erected satisfactorily on the premises. It may be necessary to run the antenna onto the property of a neighbor. In such cases, be certain that the customer obtains permission for the erection of the antenna.

You should keep the antenna away from trees, shrubbery, and phone and power lines as much as possible. The lead-in wire should go as directly as possible to the window nearest the receiver location in the home. Be sure to question the home owner about this, because he may want to move the radio to a different location in the room before the installation is completed.

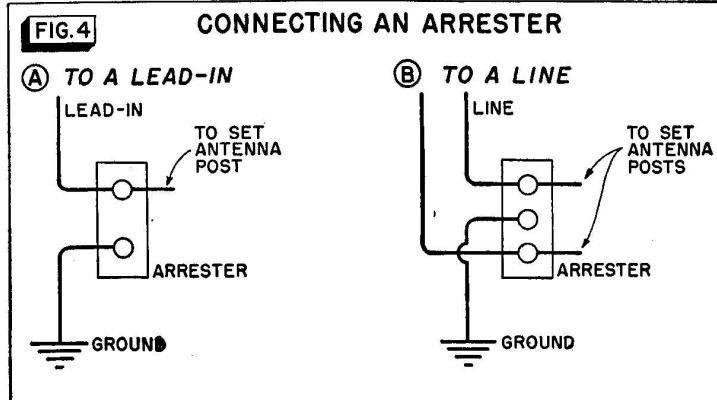
If there is a convenient chimney, it can be used as one support for the antenna or as a support for one of the antenna poles. The other end may have to be mounted on a tree, on a tall mast in the yard, or on a mast on a garage roof, for example.

► Finally, you should plan the installation so that it will meet with the approval of the Fire Underwriters—otherwise the fire insurance of the home owner will not be valid. The first requirement is that the antenna system be kept well away from all power lines, so that it will be impossible for the antenna to fall on the power lines or vice versa. (This is desirable anyway, because power lines carry a lot of interference that may be passed on to the antenna and thus to the receiver.) The lead-in must be securely anchored and kept away from power line leads also, so that it will be impossible for it or the power line to sway in such a manner that they can come in contact.

A lightning arrester is required, because the antenna may act as a lightning rod and may attract lightning discharges. Fig. 3 shows the details of a standard lightning arrester. It consists of two sharp points, close together, in a small vacuum chamber. (Some arresters have the points sealed in gas-filled tubes.) The spacing is such that normal signal voltages cannot cause an arc to form between the points, so radio signals are not affected. However, when a lightning discharge comes along, the extremely high voltage easily bridges the gap and the charge is leaked away to ground.

Fig. 4 shows how lightning arresters should be installed in the two common antenna systems. In either, mount the lightning arrester at the point where the lead-in enters the building, and run the straightest possible ground wire from the ground terminal of the arrester directly to the earth or to a cold-water pipe. Then the energy of any lightning discharge will be dissipated directly to ground through the arrester, instead of coming into the house.

► In many cases there are local ordinances about the erection of antenna systems that must be observed. Make sure you learn (from a fire insurance inspector or an electrical inspector) what these requirements are before you start to install any antenna. For example, you may have to drive a certain kind of pipe into the earth for the ground connection of the lightning arrester; this may have to be a certain number of feet from an electrical system ground; and there may be regulations as to the depth to which it should be driven, etc.



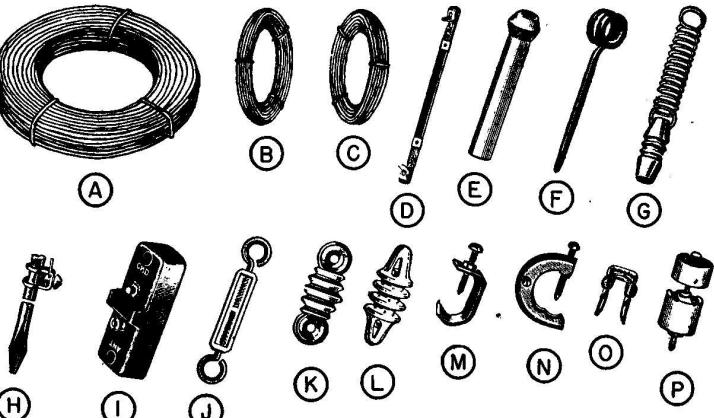


FIG. 5. The parts used in installing an antenna. You can get them from radio supply houses, either separately or in kit form. A, antenna wire; 7-strand bare or enamel copper wire. B, lead-in and ground lead wire; No. 14 or No. 18 rubber-covered tinned copper wire, solid or stranded. C, galvanized steel guy wire for anchoring masts. D, window lead-in strip. E, porcelain wall tube; used to bring antenna lead-in and ground leads through a wall. F, stand-off insulator; used for holding a lead-in wire away from the wall. G, tension spring with insulator; sometimes inserted in antenna guy wire to keep it taut and relieve strain. H, ground rod, 4 to 6 feet long. I, lightning arrester. J, turnbuckle; used to tighten guy wires. K and L, insulators for antenna wire. M, and N, ground clamps. O, insulated staple. P, nail-it knob; used for fastening wires to outside walls.

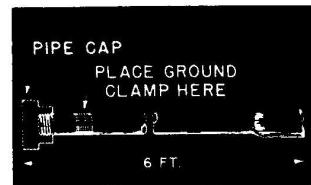
INSTALLING AN INVERTED L ANTENNA

The horizontal antenna wire is usually about 50 feet long, although a length of from 20 to 100 feet may be used if the space requires such a value. The amount of lead-in wire necessary will depend upon how high the antenna can be erected. Naturally, the higher it is, the longer the lead-in wire that is needed. It is best to keep the over-all length of the flat top and lead-in under 100 feet if there are nearby stations; otherwise their signals are so strong that they may cause interference. Longer lengths are permissible in remote districts, however.

You can purchase all the needed equipment for the erection of an antenna in a complete kit form, or you can purchase the individual parts you require. Here are some suggestions.

Fig. 5 shows all the parts needed for installing an inverted L antenna. You have a choice of styles of parts in some cases. For example, the lead-in strip D

FIG. 6. You can make a good ground rod from a pipe of any convenient diameter by beating one end flat. Screw a top cap onto the other end, then drive the pipe about 5 feet into the ground. Fasten a ground clamp to the exposed end of the pipe.



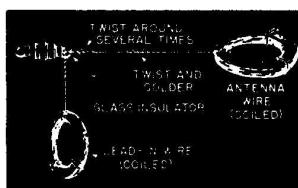
and the porcelain tube E give alternate methods of getting the antenna into the house. (These will be described later.) Similarly, the stand-off knob F and the nail-it knob P are used interchangeably—so are the insulators K and L, a pair of which will be needed. The ground strips M and N are both popular types; you may find one or the other required by local electrical codes, but if not, either style may be used.

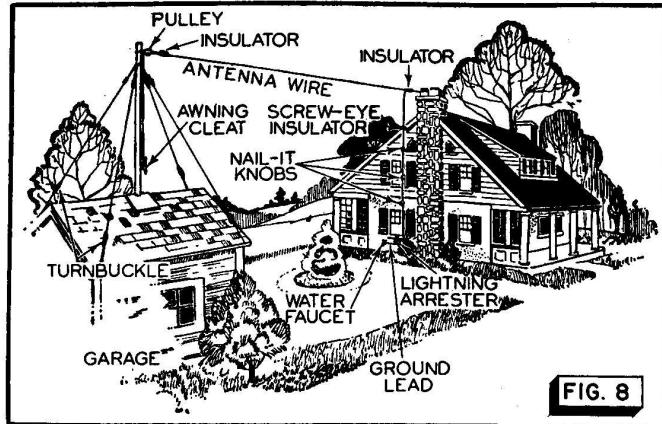
If you do not obtain the patented ground rod H, then you can make a ground rod out of a piece of pipe, as shown in Fig. 6.

► Let's suppose you have completed your survey and have decided how you want the antenna to be installed. The next step is to attach the lead-in wire to the antenna. This should be a soldered connection, so the operation is best done on the ground.

Fig. 7 shows a very good method of fastening these together. First, thread one end of the antenna wire through one hole in a glass or porcelain insulator, then tightly wrap the end of the wire around itself for a length of 6 or 8 inches. Next, thread about 15 inches of the lead-in wire through the same insulator hole and wrap the wire tightly around itself several times to make a strong mechanical joint that will not pull loose. Now remove the insulation from the end of the lead-in wire, and clean the wire with sandpaper or a knife. Clean the antenna wire in the same way at the point where the lead-in is to be attached. Twist the end of the

FIG. 7. Here is a good way to fasten the lead-in to the antenna. Twist the antenna wire back on itself enough times to make a very strong joint. If possible, do this work in your shop where it will be easier for you to solder the lead-in to the antenna wire.





lead-in wire around the antenna wire, tightening the joint with pliers, then solder the joint. Leave both the lead-in and the antenna wire coiled for the time being, to prevent them from becoming tangled.

► Now, as an example, let's suppose you are making an installation similar to that shown in Fig. 8. A chimney is to serve as one support. To fasten the antenna to the chimney, loop a length of galvanized guy wire (No. 12 or 14 wire) around the chimney. Be careful that the guy wire does not cut between bricks of the chimney, for the mortar is easily cut away, and the guy wire can actually clip the top from a chimney. Fasten the guy wire so that it is against brick all the way around, if possible.

Insert the guy wire through the remaining hole in the insulator to which you have fastened the antenna and lead-in. Next, twist the ends of the guy wire firmly together. You can now un-coil the antenna and the lead-in wires and allow them to drop to the ground.

The installation in Fig. 8 requires a mast—we'll describe how to construct it in this Booklet. For now, let's assume that you have the proper mast assembly ready for erection. It should have a pulley fastened to it near its top. Thread a rope or guy wire through this pulley, then get on top of the garage and set the mast in place. Anchor the mast upright with guy wires fastened to the roof. These guy wires should have turnbuckles in

them so that the wires can be drawn taut to hold the mast vertical.

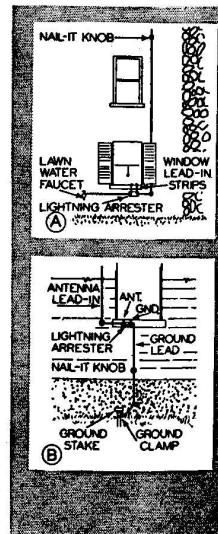
After the mast is erected, attach the rope or guy wire running through the pulley to another glass or porcelain insulator, then fasten the antenna to the other hole in the same insulator. Pull up the guy rope. If you have misjudged the distance and the antenna is too long, let it down and cut off some of the wire. When you have the wire cut to the proper length, pull the guy rope so that the antenna is fairly taut. Don't pull it too tight, however, since allowance must be made for expansion and contraction of the antenna wire with temperature changes. Wrap the end of the guy rope around an awning cleat or otherwise fasten it to the mast.

► Once the antenna has been erected, it is possible to bring the lead-in down to the house and fasten it. (This cannot be done until the antenna has been completely erected, however, as the lead-in will be pulled up and down with shifts in the antenna position.) To prevent antenna movements from breaking the wire, leave some slack in the lead-in when you bring it down to the first fastening on the side of the house. Thereafter, however, fasten the lead-in tight along the side of the house down to the point of entry so that it cannot whip about.

You can thread the lead-in down through a screw insulator, or you can use nail-it knobs. To use the nail-it knob, place the lead-in wire in the groove provided in the knob, and then nail the knob to the side of the house. This holds the wire firmly. Always use a nail-it knob as the first lead-in fastener.

Mount the lightning arrester next, then bring the lead-in down to the arrester and remove enough insulation to permit looping the bare portion of the lead-in wire around one arrester terminal. Tighten the terminal nut on the arrester. Now, run a ground wire from the lightning arrester, as shown in Fig. 9. Incidentally, the lead-in wire should

FIG. 9. Two ways of making ground connections: A, to a faucet; B, to a ground stake.



come straight down to the arrester, and the ground wire should go from the lightning arrester in a straight line to the ground connection. Clean the water pipe or ground rod with sandpaper, then use a ground clamp to make connection to it.

After having made connections at the lightning arrester, you can bring the antenna lead-in into the house. There are three ways of doing this, depending on the installation. In one, you can use a lead-in strip of the type that is placed under a window. This is a flexible strip made so that the window can still close after the strip has been placed across the sill. The lead-in wire is run from the lightning arrester to the outside Fahnestock clip, and then another wire is run from the inside Fahnestock clip to the radio receiver. (To prevent poor connections at the clips, many servicemen solder these connections.) Make the inside wire as inconspicuous as possible by using wire with brown or cream-colored insulation, whichever is closer to the color of the interior woodwork.

Sometimes a receiver has its own ground connection inside the house. However, if there is no separate ground for the receiver, bring in another wire (again, an inconspicuous one) from the ground terminal of the lightning arrester through another strip to provide the ground connection for the receiver.

If the window has been weatherstripped by metal stripping that fits into a groove in the window, you cannot use the window lead-in strip. One way to avoid this difficulty is to drill a hole in the window frame or in the side of the house to bring in the lead. For this purpose, a porcelain wall tube may be used. If you find it necessary to follow this procedure, be sure to drill the hole so that it leads *upward into the house*. This will cause the tube to point downward toward the outside and will prevent rain from coming in through the hole.

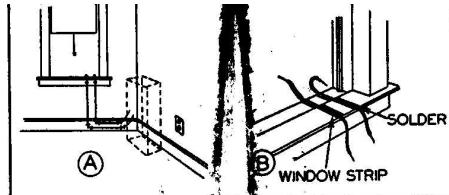


FIG. 10. How to bring lead-in wires through a window to a receiver.

Since drilling this hole is frequently difficult, particularly in brick homes, most servicemen bring the antenna lead-in through a basement window, then run the wire along under the floor and up through the floor to the radio. This requires a small hole in the floor near the radio location. Some owners object to

this, but if there is no better way of getting to the radio, you can explain that the hole need be only a very small one. Drill the hole downward through the floor, using a $1/8$ " or $3/16$ " drill, and make the hole inconspicuous by placing it just as close to the base-board as possible.

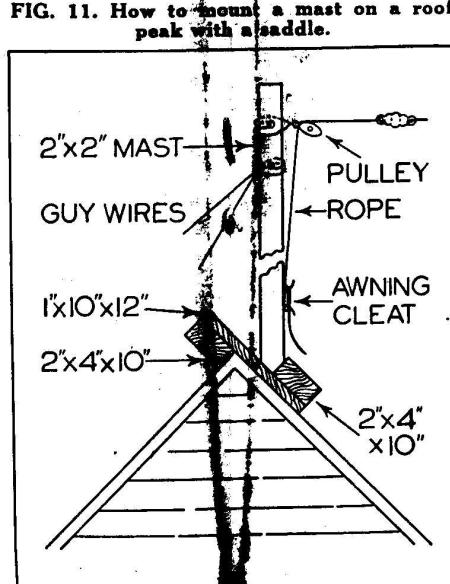
Fig. 10 shows the lead-in connections when the wire comes through a window. Be sure to nail the wires neatly to the baseboard with insulated staples of about the same color as the baseboard. Keep the antenna and the ground leads separated as much as possible—preferably by at least two or three inches. (When you have to make a hole in the floor, it is not always possible to keep these wires separate at this point.)

This completes the installation of a simple inverted L antenna system. In general, all systems of this kind will be erected in the same manner. Perhaps the major difference between the installations will be in the supports of the antenna wire. Sometimes you will have to make one or two masts for the system; in other cases there will be trees in convenient locations. Let's learn more about antenna masts.

ANTENNA MASTS

The kind of mast shown in Fig. 8 may be made of $2" \times 2"$ timber in some standard lengths, such as 6, 8, or 10 feet. There must be a support for the bottom end of the mast so that it will not punch its way through the roof. It is possible to use two pieces of wood to make a saddle for the roof, or, if the roof is flat, the mast can be fastened at the butt end on a flat board.

Fig. 11 shows another way of fasten-



ing the mast at the peak of a roof. Here, two pieces of 2" x 4" are nailed to a 1" x 10" by 12" board. Trim the butt of the antenna mast to fit the saddle snugly. Fasten the mast at its base by driving one nail up through the board into the end of the mast and driving one or two more nails sideways into the 2" x 4" next to it. Be careful not to split the mast.

Then, to prevent the guy wires and the antenna guy from slipping down the mast, drill two small holes through it. Drill one about two inches below the top. Thread the guy wire for the pulley through this one, and thread the mast guy wires through the other. Wrap each guy around the mast once or twice, then fasten it by twisting both parts of it together. The awning cleat shown near the base of the mast may be obtained from any hardware store and is fastened to the mast by wood screws.

► Fig. 12 shows a method of securing the antenna to a tree. A loop of galvanized iron wire is passed around some portion of the tree above a branch crotch so that it cannot slip downward. It is a good idea to thread this wire through a section of an old bicycle tire so it will not cut into the tree. Then the antenna wire can be guyed through a pulley to a heavy weight to hold it upright. It is advisable to use a weight system of this kind, because a tree will sway with the wind and will snap the antenna wire if it is drawn up taut. Another scheme is to use a long spring between the insulator and the tree guy wire instead of using the pulley and weight. The swaying tree stretches the spring.

The antenna wire itself and its insulator must be outside the tree area—that is, no tree branches should rub on the wire. Either use a sufficient length of clothesline back to the pulley to avoid this possibility, or trim the tree.

How to Build a Tall Mast. When there is no nearby house, tree, garage, or barn to which you can attach the far end of the antenna, a mast erected on the ground

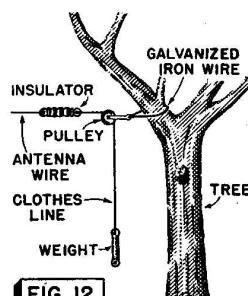


FIG. 12

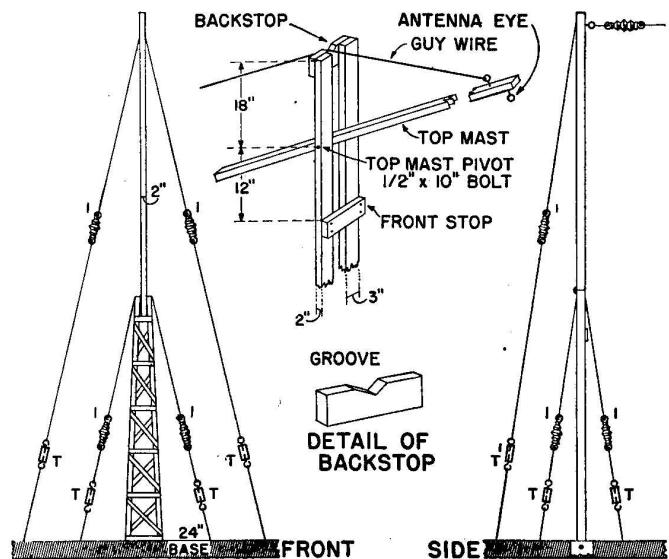
will solve the difficulty. The mast shown in Fig. 13 is very satisfactory. It is strong, inexpensive, and can be built and erected by one man who is handy with a saw and hammer. In addition, it has the useful feature that the antenna can be attached or replaced without lowering the bottom portion of the mast. The following details may not be clear until you build one, but the complete step-by-step procedure is given.

The mast is in two sections. The lower section (we will call it the lower mast) is a light but substantial latticed affair. The upper section (top mast) is a single pole, pivoted to the upper end of the lower section.

The lower mast is made from two lengths of 2" x 3" wood between 12 and 20 feet long. Lay these two pieces on the ground, 3" sides uppermost, spreading the bottom 24" and the other end slightly more than 2". Lattice first one side and then the other with 1" x 2" strips, nailed to the 3" faces. The latticing pieces should stop 36" from the top.

Thirty inches from the top, screw on a piece of board about 1" x 8 1/2". This is shown in Fig. 13 as the *front*

FIG. 13. Construction details of the tall mast.



stop for the top mast. The *back stop* is a 2" x 4" piece of wood, screwed or bolted on the other side at the extreme top. Notch the upper edge of the back stop in a broad V about 1" deep.

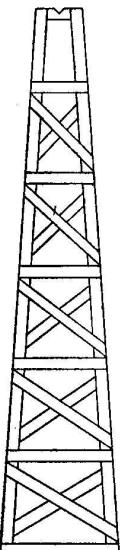
Fasten four large-sized eye screws within 3 feet of the top of the lower mast (drill through the 3" faces of the uprights), and attach a guy wire to each eye. Each wire should be about one-quarter longer than the lower mast, and, if possible, should have a turnbuckle in it near the end farther from the mast. These guy wires are to be fastened in stakes driven in the ground. For this purpose, drive four 2" x 3" stakes (or tent pegs) about 2 feet long into the ground around the place where the mast is to be mounted. Put them in the four corners of a square so that each will be about one-half the length of the lower mast from the base of the mast. Drive each in at an angle so that it will slope away from the mast, then fasten an eyebolt to each.

To make the base for the lower mast, use two 2" x 3" stakes 2½ feet long. Point one end of each stake with a hatchet and drive them about 2 feet into the ground where the mast is to be erected. Space them 30" apart. The 3" sides of the stakes should be parallel in the same direction as the antenna will run. For permanence the stakes should be treated by dipping them in creosote—if you wish, they may also be set in concrete rather than be driven into the earth.

Cut off the tops of the stakes so that 3 inches of each remain above ground. Drill holes large enough to hold a $\frac{3}{8}$ " or $\frac{1}{2}$ " diameter bolt through the 3" faces of each. With the same bit, drill similar holes on both sides of the base (through the 2" faces) of the lower mast. Finally, fasten the lower mast to the base with two galvanized iron bolts. The lower mast is to pivot on these bolts, so don't tighten them too much.

For the top mast, select a 2" x 2" pole about 10 to 15 feet long, free of knots and

Here's how to lattice the base of the mast shown in Fig. 13.



flaws. Drill a bolt hole 18" from one end of the pole and drill corresponding holes through the end of the lower mast.

Attach the pole to the lower mast by slipping a $\frac{1}{2}$ " diameter galvanized iron bolt through the holes in both masts. Leave the nut on the bolt loose enough for the pole to pivot freely.

Fasten two eyebolts to the other end of the pole, one on the side that will be nearest the house, the other on the opposite side. Fasten three guy wires to the latter eye. These wires should be 25 per cent longer than the entire mast. After making each wire the correct length, cut it in half and attach the cut ends to the holes of a strain insulator. (This is to prevent leakage from the antenna to ground along the guy wires.) Next, install a turnbuckle in each guy near its bottom end.

You are now ready to pull up the lower mast. With the lower end bolted to its anchor, find the two guy wires that will reach their pegs while the mast is on the ground, and make a temporary fastening to the corresponding eyebolts on these pegs. Let these wires be a little longer than they will be when the mast is upright.

Lay one of the top-mast guy wires over the notch in the back stop, then lift the lower mast and swing it into place, allowing it to hang on the guy wires.

Fasten the other two lower-mast guy wires to their anchor-peg bolts, then adjust all four guy wires until the lower mast is vertical. When you have it almost vertical, fasten the wires permanently to their anchor bolts, and make final adjustments with the turnbuckles. See that all four guy wires are taut.

Drive three more anchor posts into the ground for the top-mast guy wires. Each should be spaced from the mast base a distance equal to about half the over-all height of the mast. Place two at the sides, about 3 feet on the house side of the lower mast, and place the third behind the lower mast, right in line with the top mast.

With a short guy wire, fasten the antenna insulator (which should already be fastened to the antenna) to the free eye on the top mast. Arrange the antenna wire so that it can uncoil as the mast is raised. (To prevent kinking, stretch it out along the ground, or arrange

it in loose coils near the base of the mast.)

To raise the mast, first prop the "antenna" end as far off the ground as possible. Use a long pole to push it up. (It helps to have an assistant for this operation.) The upper mast can now be brought into position by pulling on the guy wire laid over the notch in the back stop. (If the wire has slipped from the notch during the raising of the lower mast, either flip it in again, or lift it in with a pole.) When erect, the top mast will rest in place against the front and back stops, and the guy wire will leave the notch. Bring this wire back to its anchor post and fasten it securely, then lead the side guy wires to their anchor posts and fasten them. Take up on the turnbuckles until all guy wires are taut.

This completes the erection of the mast. You can now fasten the other end of the antenna to its support in the manner previously described.

ERECTING A DOUBLET ANTENNA

Doublet antennas have been made that use a shielded cable or a spaced pair of wires for a lead-in, but practically all those intended for home installations use transmission lines consisting of a twisted pair of wires. This last is the only kind we will discuss here.

In practically all cases, the transmission line is matched to the impedance of the flat top, either by an antenna transformer or by careful design of the line and flat top so that they have the same impedance. Therefore, these units, including the horizontal portion and the transmission line, are always sold as complete kits. Typical systems are shown in Fig. 14.

Notice that the lengths of the various antennas vary. As these wires should not be cut if optimum short-wave reception is desired, it will be necessary for you to

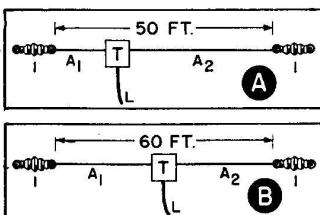
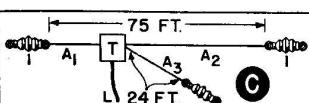


FIG. 14 DOUBLET ANTENNAS

A = ANTENNA WIRE, I = INSULATOR
L = TRANSMISSION LINE
T = TRANSFORMER



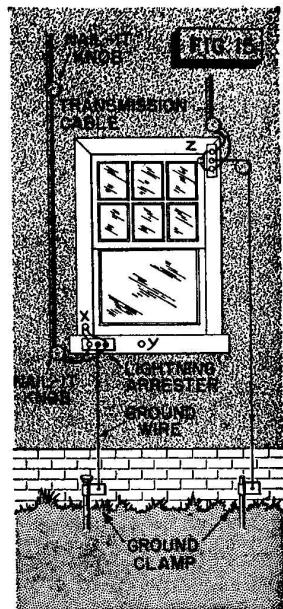
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choose antenna kits that have approximately the right spread between the insulators for the installation you have in mind. (These length variations occur because each antenna represents a compromise between best noise-rejection and best signal-pickup. Some have greater noise-rejection, others have better pickup.)

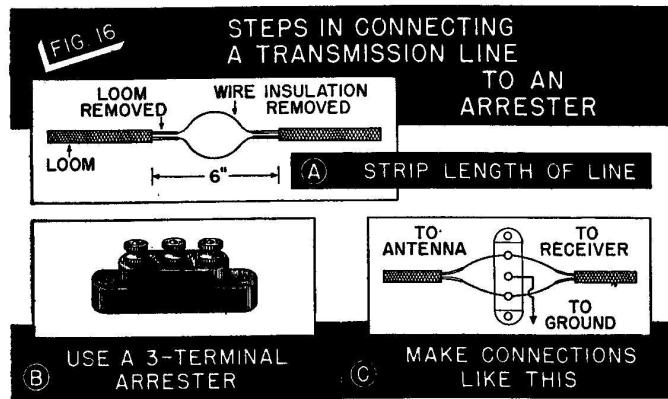
Another important consideration is the fact that these antennas are directional. As shown in Fig. 2, most of them receive best from the broadside direction, so if a particular short-wave station is to be picked up, it may be necessary to orient the antenna system properly for it. Incidentally, antennas of the type shown in Fig. 14B are also used for television and f.m. reception, except that the horizontal flat top is a metal rod and is much shorter—5 or 10 feet long. A television or f.m. antenna of this kind is supported by a single mast at its center. (Because of special erection problems, we will not cover television and f.m. antennas here.) All other noise-reducing antennas, however, need supports at both ends, just as an inverted L antenna does.

To erect a noise-reducing antenna system, first erect the flat top in the manner described for the inverted L. Get it as high in the air as possible, but, of course, no higher than the length of the transmission line unless you can obtain more of the same kind. Bring the transmission line down to the point of entry into the house, fastening it to the side of the house with nail-it knobs or screw eyes. Do not separate the two wires of the line in any manner until you have brought it to the point of connection with the lightning arrester.

Fig. 15 shows two possible positions for mounting the lightning arrester. Notice that the transmission line



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is shown entering the house through a hole after being connected to the arrester. The use of a hole allows the line to be kept twisted together, which is always preferable. However, if necessary, the line can be separated and two window lead-in strips used to bring the wires under the window. In any case, the line must be separated to be connected to the arrester. Fig. 16 shows how this is done. A typical arrester and the connections to be made are also shown. Notice that a three-terminal arrester is used.

If the receiver has connections for a doublet antenna, simply connect the ends of the transmission line to the terminals provided, and connect a ground wire to the ground terminal. If the receiver has only antenna and ground terminals, then a matching transformer like that shown in Fig. 17 must be used. This can be purchased with the antenna kit.

INDOOR ANTENNAS

If it is impossible to erect a worth-while outdoor antenna, and the receiver is not equipped with a loop antenna or a built-in antenna

FIG. 17. A typical matching transformer, used when a receiver is not equipped for doublet connections. The wires marked "TO SET" connect to the ground and antenna posts of the set; they are coded to show which is which.

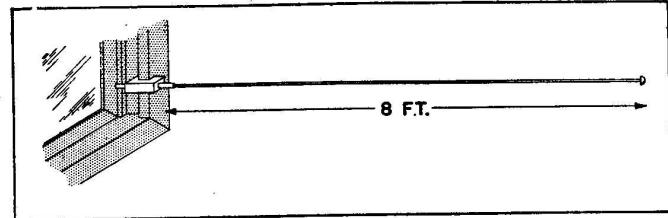
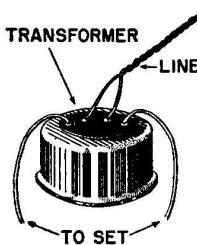


FIG. 18. One common type of fishpole antenna. These are adjustable so that they can be turned horizontally, vertically, or at some convenient angle. Usually angle mounting is best.

of any kind, then frequently some kind of indoor antenna must be used. At best, these give poorer results than any outdoor system, and may prove impractical altogether in buildings having steel in their construction.

Essentially, an indoor antenna is just a length of insulated wire strung up in some convenient part of the house. The wire may be run around three sides of a window frame; it may be run around the baseboard or around the picture molding; or it may be run through the wall up into an attic and then along the length of the house in the attic. Of the three, the last—giving both a longer and higher antenna—is by far the best, but it may be too difficult to install.

► When the building has metal in its construction, none of these indoor aerials may be practical. In such cases, a window fishpole antenna (Fig. 18) can be used. This is a metal rod 6 to 10 feet long that mounts on a window frame. Thus, it gets outside the building area and will pick up better than many of the indoor antenna systems. There are several types available.

Many antenna eliminators are on the market. Most of these plug into the power line, connecting the antenna terminal to the ungrounded side of the power line through a small condenser. The power line then acts as an antenna. Usually, however, so much noise feeds into such devices that their use is not recommended.

CHECKING ANTENNA SYSTEMS

It is always advisable to look over the antenna system when you are called on any radio service job. Before entering the home, look over the outside antenna

if there is one. See whether the flat top is up and clear of all surrounding objects, and check the lead-in wire as far as you can see it to determine if there are any obvious breaks or defects in the system. Then, when you are within the home, examine the wire on the inside of the house, and check the rest of the lead-in.

The antenna system is a logical suspect whenever the receiver plays more weakly than normal, does not pick up distant stations, and is excessively noisy. If the receiver is in a shielded location, a broken lead-in may even make the receiver dead.

Whenever a defect is found in an antenna system, determine the age of the system. If it is more than three years old, it is usually better to replace the system rather than to repair it. This is particularly true if the trouble involves the transmission line of a noise-reducing antenna system. These lines become brittle with exposure to weather, and the insulation deteriorates. Also, collections of soot and dirt on the insulators may cause excessive leakage.

You can check with an ohmmeter for leakage from the antenna system to ground. However, before using an ohmmeter, be very certain that the antenna system does not touch any power line. In fact, many servicemen take the precaution of first checking between the lead-in and ground with a voltmeter capable of measuring line voltage.

To make this check, disconnect the antenna and ground leads from the receiver. Then connect your voltmeter probes between these two leads. Use a range higher than 110 volts at the start. If you get a voltmeter reading, the antenna system is in some manner shorted to a power line. Such a short circuit could burn out the antenna coil of the receiver. In fact, if you get a very high reading, it is advisable to have the power company come out and clear the short circuit rather than attempt to do it yourself.

If you get no voltmeter reading, then it will be safe to use your ohmmeter and make a test between these two points. If you get an ohmmeter reading, the antenna is leaky and should be replaced. Use a high ohm-

meter range, because you should get no reading whatever.

Such an ohmmeter check will not show if there is a break in the lead-in. You can find this only by shaking the lead-in wire and pulling on it to see if you can part it at some point.

A transmission line should have continuity through the two wires of the line. If the transmission line is matched to the flat top by a transformer, there should be continuity through the transformer and line. In this case, measure between the two wires at the receiver end, and you should get a reading above 10 ohms (but not more than 100 ohms in the average installation). If the reading is lower than 10 ohms, there is a possibility of a short circuit between the wires of the line; on the other hand, no reading indicates an open. Of course, if there is no transformer, you will get no reading, because the transmission line is not joined at its upper end. If it is easy to get to the upper end, you could temporarily short together the antenna end of the transmission line. Then, by measuring between the receiver ends, you will get a reading of 10 to 100 ohms. If it is too difficult to get up to the top, then replace the system if it seems at fault. (The best test of this is to try the receiver on another antenna. If it works normally on a system known to be in good condition but operates poorly on the suspected system, then that system is defective.)

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